Journal of Computer Science & Computational Mathematics, Volume 5, Issue 2, June 2015
DOI: 10.20967/jcscm.2015.02.001

Causes of Low Mathematics Achievements in a Private University

Izyan Syazana Awaludin, Ruzanna Ab Razak*, Nor Azliana Aridi , Zarehan Selamat

Faculty of Management, Multimedia University, 63100 Cyberjaya, Malaysia
*Corresponding author email: syazana.awaludin@mmu.edu.my

***Abstract*:** The high failure rates in mathematics courses have been a concerning matter in each semester at private universities. Studies about determining the causes of low mathematics achievement are very limited. The purpose of this study is to investigate the factors that affect low achievement in mathematics. In order to achieve this purpose, factor analysis was conducted to capture the potential factors which may affect achievement. Multiple linear regression was used to determine the factors that significantly affect the achievement in mathematics. A total of 111 students who enrolled in mathematics courses participated in the survey. This study revealed that one of the significant causes of low mathematics achievement is students' educational background. Students who were not from science stream are at a disadvantage in achieving good performance in mathematics. Other factors of low mathematics achievement include race, age and students' valuing of the importance of mathematics. One of the implications discussed in this paper is that mathematics educators must have several effective teaching strategies that suit students' learning needs especially non-Chinese and older students. Such strategies might help educators achieve the desired learning outcomes and reduce failure rates.

***Keywords*:** mathematics achievement, education, multiple linear regression**.**

1. Introduction

Mathematical knowledge has long been recognized as an important course as their applications are widespread. Most university programmes require students to take a minimum of one mathematics course. The rationale of requiring university students to enroll in one Mathematics course is to provide students with essential mathematical knowledge and develop their analytical and computational skills they need in their area of specialization.

Teaching mathematics to students from non-science programmes at university level has been tough. Mathematics courses are one of the few courses whose failure rate can easily exceed 30 percent. This statistic is true for many business programmes at tertiary education level in Malaysia. Mathematics educators have been changing teaching styles in order to suit students' intellectual levels and reduce failure rate without lowering the quality of the course. Hence, there is a need to study and tackle the root cause of poor mathematics performance at university level.

Some studies [1, 2] about determining factors that influence mathematics performance have largely been conducted at school levels. Numerous researches have shown that mathematics anxiety is one of the psychological factors that influence students' achievements in mathematics. Mathematics anxiety can be defined as a feeling of tension that appears when someone needs to deal with mathematical problems not only in academic but also in daily life [3]. Richardson and Suinn [4] view mathematics anxiety as feeling of tension, mental disorganization, worry and disruption when dealing with numbers and mathematical problems. In mathematical context, it appears that students who are weak in mathematics are often worried when they are solving mathematical problems. Previous studies found that students' mathematics anxiety has a strong relationship with their achievement in the course [5, 6]. When students have high levels of mathematics anxiety they will start to have negative thoughts of their self-ability in learning mathematics thus achieving lower performance in mathematics [7].

Students' achievement in mathematics were also said to be positively influenced by students' attitudes towards the course [8, 9]. Attitude is one of the most important psychological constructs that affects students' learning experiences. It is also the most frequent factor studied across all levels of education. In addition, students' valuing the importance of mathematics was also claimed to have positive affect on students' mathematics performance. On the contrary, Lazarus [10] identified fear of mathematics or mathematics anxiety, educational issues, values and expectations towards mathematics subject as causes of poor mathematics achievements among students.

Past studies also reported that age, gender and parents' education level have positive association with students' performance in mathematics [1]. In terms of race, Chinese students usually tend to perform better in mathematics course compared to the Malays. This dissimilarity is due to the students' cultural upbringing. According to Wong and Quek [11], Chinese students paid more attention during class, helped others through their own explanations, practiced past year examinations, did practical activities and solved puzzles. The latter activity kept students' mind sharp.

Together, the above studies revealed that mathematics anxiety, students' attitude towards mathematics and their valuing mathematics have significant effect on mathematics achievement at school level. Besides that, demographic variables such age, gender, parents' education level and race also influence the achievement in mathematics significantly. The evidence of the relationship between those variables and students' mathematics achievement at tertiary level is limited. Based on the authors' current knowledge, there are very few

studies on causes of poor mathematics achievement at university level. Therefore, this study aims to investigate factors that caused poor achievement in mathematics at a private university.

The current study also considers the location of students' hometown, their education background and the number of attempts of taking mathematics course as demographic variables that could impact their mathematics achievements. To our knowledge, no previous studies have investigated the influence of these variables on achievement.

The outcomes of this research will give insights to mathematics educators about the causes of low mathematics achievement. It also helps mathematics lecturers in planning appropriate strategies in order to draw students' interest in learning mathematics and minimize failure rates in mathematics courses.

2. Methodology

2.1 Participants

The participants of this study consist of 111 business administration students from Multimedia University who are part of the 55% response rate. The participants were from four departments in the faculty: management, marketing, finance and economics. Mathematics is a compulsory course that must be taken by all students in order to complete their studies.

From the sample students, 51.4 percent of the participants ($n = 57$) were female students and the remaining 48.6 percent were males ($n = 54$). In terms of race, 53.2 percent were Malays, 18.9 percent were Chinese, and 12.6 percent were Indian and others 15.3 percent. 49.5 percent of the participants were from science background.

In terms of location of students' hometown, 25 percent of the students were from rural areas, 67.3 percent were urban and others 7.7 percent. In addition, 23.42 percent of students have parents whose highest education level was postgraduate, 27.03 percent was graduate, 21.62 percent was college graduate, 27.03 percent was secondary school graduate and 0.9 percent was primary school graduate. Besides that, 97.75 percent of the students were taking this course for the first time.

2.2 Instrument

During the academic session 2013/2014, questionnaires were distributed to students who were taking mathematics. The questionnaire consists of 9 statements related to students' attitude toward mathematics (Attitude), 15 statements related to mathematics anxiety (Anxiety) and 6 students-valuing mathematics (Importance) statements. These statements were extracted and modified from the survey used by Morony et al [12] and also in the Trend in International Mathematics and Science Study [8]. Each statement used a Likert scale ranging from strongly disagree (coded 1) to strongly agree (coded 5). A reliability test was conducted to ensure that the statements is related to one of the key factors. Table (1) below shows the results of the reliability test using Cronbach's alpha.

TABLE 1. Reliability test results

Variable	Cronbach's Alpha
Attitude	0.91
Math Anxiety	0.94
Importance of Math	0.81

It can be seen from the table above that the Cronbach's alpha for each variable are greater than 0.70. The high value of alphas suggests that the measurement scales used in the survey are acceptable and reliable. This reliability test result also ensures that the statements related to attitude, anxiety and important of mathematics are freely and readily understood by participants.

Now, in order to measure mathematics achievement, the participants answered a test which was conducted by their mathematics instructor. The test scores were standardized to 100 percent. Basic information such as age, gender, race, location of hometown, parents' educational level, students' education background (ScBG) and status of student enrolled in course either first attempt or repeating were captured at the demographic section in the questionnaire. Table (2) below summarizes the categorical demographic variables and their coding. The first category for each variable is coded 0. Based on several testing, we found that the magnitude effect of each variable towards the dependent variable does not change.

TABLE 2. Demographic variables and their coding

Variables	Variable Name	Coding
Gender	Gender	0 = female, 1 = male
Race	Race	0 = Malay, 1 = Chinese, 2 = Indian, 3 = others
Location of hometown	Location	0 = Rural, 1 = Urban, 2 = others
Science background	ScBG	0 = Science, 1 = non-Science
Parents' education level	ParentsBG	0 = Postgraduate, 1 = Undergraduate, 2 = College graduate/ professional, 3 = Secondary education, 4 = Primary education

Status of study	Attempt	0 = First, 1 = Second

2.3 Statistical methods

Factor analysis method is employed in order to confirm if the statements belong to the three main factors of this study. Besides that, it can also be used to uncover any potential factors that may affect students' mathematics achievement [13]. To ensure that the statements are sufficient for factor analysis, the Kaiser-Meyer-Olkin (KMO) measure of appropriateness of factors analysis and Bartlett's test are calculated. The dataset is considered marvelous fit for factor analysis if the KMO value is greater than 0.9. The minimum KMO value cut-off for validating appropriateness of the dataset for factor analysis is 0.6. Bartlett's test is used to test the null hypothesis that the correlation matrix of statements is an identity matrix. If the null hypothesis cannot be rejected, the statements are uncorrelated thus not appropriate for factor analysis. Factor analysis can only be used if the statements are correlated.

In order to determine which potential factor affects students' mathematics achievement, multiple linear regression analysis is used. The demographic variables (DVs) are included into the regression analysis since they could influence mathematics achievement. The general regression model is provided by equation (1).

$$A = \gamma + \sum_j \beta_j DV_j + \sum_j \delta_j F_j + \omega \qquad (1)$$

While A represents students mathematics achievement, β_j and δ_j denotes the coefficients of each j-th demographic variable and factor, respectively. In this equation, ω denotes the error term while γ is the intercept of the model. Factor j represents the factor obtained from factor analysis. All analyses are carried out using R programming.

3. Results

The average mathematics score per student is 54.11 and the standard deviation is 23.78. The median score is 56. Half of the total students scored 56 and above while another half scored 56 and lower. Through correlation analysis, achievement and age have significant negative correlation of -0.3374. Correlations between statements related to anxiety, attitude and importance of mathematics were mostly above 0.5. The correlation matrix for statements is not shown in this article in order to save space. The results are readily available upon request.

In order to ensure that the 30 statements belong to three key factors of interest (anxiety, attitude and importance of mathematics), factor analysis was applied to the dataset. The value of the Kaiser-Meyer-Olkin (KMO) measure of appropriateness of factors analysis is 0.87 which indicates that the statements are meritorious for factor analysis. Furthermore, the highly significant value of the Bartlett's test indicates that the 30 statements are correlated and they are appropriate for factor analysis. The results of factors analysis are shown in Table (3), (4) and (5). Table (3) lists statements that represent attitude and their factor loadings. Table (4) and (5) lists statements related to mathematics anxiety and importance of mathematics, respectively, as well as their factor loadings. All negative statements were reverse coded.

TABLE 3. Statements of attitude and their factor loadings

Statement	Factor loading
I learn Mathematics quickly.	0.646
In my Mathematics class, I understand even the most difficult work.	0.746
I am just not good at Mathematics.	0.552
I have always believed that Mathematics is one of my best subjects.	0.813
I usually do well in Mathematics.	0.739
Even if the work in Mathematics is hard, I can learn it.	0.678
I am sure I can learn the skills taught in Mathematics class well.	0.719
I have talent for Mathematics.	0.732

TABLE 4. Statements of anxiety and their factor loadings

Statement	Factor loading
Mathematics is harder for me than for many of my classmates.	0.681
I get very nervous doing Mathematics problems.	0.657
I get very tense when I have to do Mathematics homework/ tutorials.	0.724
I often worry that it will be difficult for me in Mathematics classes.	0.769
I feel helpless when doing a Mathematics problem.	0.757
I worry that I will get poor grades in Mathematics.	0.739
I become physically uncomfortable when I have to go to Mathematics class.	0.709
It scares me to think that I will be taking advanced Mathematics classes in the future.	0.669

Compared to other subjects, I worry more about Mathematics.	0.713
I am worried about being called on in Mathematics class.	0.676
The harder I work on Mathematics, the more nervous I get.	0.639
I dread having to do Mathematics.	0.619
When the lecturer is handing out Mathematics questions/ tests, I feel like I am going to be sick.	0.654
I lose my concentration in Mathematics class.	0.601
I am afraid I would not be able to keep up with the rest of the Mathematics class.	0.601
I fear Mathematics tests more than any other tests.	0.757

TABLE 5. Statements of importance of mathematics and their factor loadings

Statement	Factor loading
Mathematics does not have any connection with the real life.	0.496
Mathematics does not have any connection with my field of study.	0.574
There is a link between Mathematics and everyday life.	0.747
I will use Mathematics in my life.	0.857
Mathematics helps develop a person's analytical and logical thinking skills.	0.800
Need Mathematics to learn other subjects.	0.718

All factors have their factor scores computed for each respondent in the dataset. The correlation between mathematics achievement and anxiety is significantly positive. 'Importance of mathematics' also has a significant positive correlation with achievement. However, 'attitude towards mathematics' has no significant correlation with achievement. Therefore, it can be expected that attitude will not significantly affect students' mathematics achievement.

To determine which independent variables significantly affect students' achievement, the regression model in equation (1) was estimated. The results are presented in Table (6) below.

TABLE 6. Estimates of regression outputs

Variables	β	SE	*p*-value
(Intercept)	119.2166	26.5743	0.0000 ***
Age	-3.4742	1.3169	0.0101**
Gender	-5.8452	4.6382	0.2113
Race1	14.2344	6.6072	0.0343**
Race2	-0.9346	7.4740	0.9008
Race3	-8.7836	7.7831	0.2625
Location1	1.7176	5.4379	0.7530
Location2	-5.7105	10.4727	0.5871
ScBG	-11.4038	4.6848	0.0172**
ParentsBG1	-6.3089	6.1581	0.3088
ParentsBG2	6.6731	6.8918	0.3359
ParentsBG3	-5.0237	6.7670	0.4601
ParentsBG4	-18.4582	22.4120	0.4127
Attempt	11.7777	5.8450	0.0473**
Anxiety	3.1668	2.2764	0.1681
Importance	4.4189	2.2973	0.0581*
Attitude	0.5991	2.0705	0.7731

Note: The p-values are marked for significance at 1***,5**,10* percent level.

For the estimated model, the F-statistics value is 3.162 and it is significant at 1 percent level. This significance explains that there is at least one factor or independent variable that can explain the variation in the dependent variable. The R square value of 0.4 implies that 40 percent of the variation in mathematics achievement can be explained by the variation in the independent variables.

Equation (2) below is the final estimated regression model with significant predictors of students' mathematics achievement, *A*.

$$A = 139.72 - 4.68\,Age + 13.18\,Race1 - 11.43\,ScBg + 10.84\,Attempt + 5.03\,Importance \quad (2)$$

'Race1' has codes: 0 for Non-Chinese student and 1 for Chinese student. 'ScBG' has codes: 0 for former Science student and 1 for non-Science student. 'Attempt' denotes the number of attempts of taking the course (coded 0 = First, 1 = Second, 2 = More than 2). The results of the diagnostic checking are not shown here but they are available upon request. In brief, the residuals of the final model seemed to exhibit normal distribution. The Cook's distance values for

all observations are lower than 0.08. The final model is better than the initial model, whose results are shown in Table (6).

As seen in Equation (2), mathematics anxiety and students' attitude toward mathematics are not significant contributors to low mathematics achievement. On the hand, students' values of the importance of mathematics have positive influence on achievement. 'Race1' or being Chinese has a major positive effect on mathematics achievement. Interestingly, the number of attempts of taking the course also shows positive influence on achievement. While age gives small negative effect on mathematics achievement, students with non-science education background (ScBg) are at a disadvantage since it greatly and negatively influence their achievement in mathematics.

4. Discussion

Studies by Sherman and Wither [5] and Elenchothy [6] have shown that mathematics anxiety has strong relationship with mathematics achievement. The current study found significant statistical evidence of weak positive relationship between the two variables. Moreover, mathematics anxiety was found to have no impact on students' mathematics performance. This result implies that at the university level students' poor mathematics performance is not affected by their fear of mathematics. There may be a possibility that mathematics anxiety affects students' statistics performance more than mathematics. Contrary to many past findings, the present study did not find significance impact of students' attitude towards mathematics on their achievement.

Another important finding is that students who felt that mathematics is important to their programmes, future career and life are more likely to have higher mathematics achievement. This finding agrees with Bandura [15] that a person who values something will have higher motivation to reach his aims.

The current study discovered that students whose upper secondary education background was non-science are more likely to get lower achievement. This variable had the highest impact on mathematics achievement. The possible reason for this is that mathematics courses for business administration students have several topics that are equivalent to topics taught for science students at upper secondary school. Therefore, for former non-science students who have never learnt such topics, learning mathematics at university is definitely a huge challenge.

The results of this study also reveals that students who are taking mathematics course for the first time tend to achieve lower results in mathematics compare to those taking it for the second time. All students had to master mathematical techniques including functions, linear programming, financial mathematics, derivatives, integration and multivariable calculus within 14 weeks of time. In a semester, many freshmen cum former non-science students were able to master half of the syllabi either calculus topics (derivatives, integration and multivariable calculus) or non-calculus topics (functions, linear programming and financial mathematics). For students who are taking the mathematics course for the second time, they generally know the content of the course and have longer time to prepare themselves in understanding mathematical techniques. Hence, they obtained higher mathematics achievement.

Another important finding is that being Chinese has a greater impact on mathematics achievement. Non-Chinese students performed worst in mathematics compared to Chinese students although Malays were the majority. This finding is in line with the finding by Mohamed et al [14]. Mathematics is a technical course which requires students to practice solving lots of problems on their own. Through series of consistent practices, students will be more familiar with the mathematical techniques. Chinese students are known to be hardworking [11]. A possible explanation of poor performance by non-Chinese students is that they may have lower self-discipline thus allowing them to feel reluctant or less dedicated to independently attempt mathematical problems.

Furthermore, age was found to negatively affect mathematics achievement. It can be concluded that older students tend to perform poorly in mathematics. This finding is consistent with the finding by White [16]. The possible reason of this low performance by older students is due to their decreasing ability to comprehend rigorous mathematical techniques. Moreover, they may have lower patience in solving mathematical problems especially when they make mistakes. However, few students realize that the right way of understanding the use of mathematical techniques in various problems is through learning from mistakes.

Finally, the current study found no significant influence of gender and parents education background on students' mathematics achievement. These findings are in contrast with many past findings. However, in Malaysian context, they support the previous findings by Abdul Rahim and Ab Razak [17]. In addition, the location of students' hometown had no significant effect to their achievement.

5. Conclusion

The objective of this study was to investigate the factors affecting mathematics achievement at a private university in Malaysia. The current study has identified that low achievement in mathematics resulted from: 1) not being a Chinese; 2) having non-science education background; 3) attempting the course for the first time; 4) disvaluing the importance of mathematics and 5) being an older student.

One implication of the findings is that mathematics lectures must have several effective teaching strategies that suit students' needs especially older students and non-Chinese students while achieving the desired learning outcomes. Furthermore, all mathematics educators should play a role in raising students' awareness about the importance of mathematics in their majors, future careers and life. There should also be an improvisation of mathematics courses offered to non-science stream students at the foundation and diploma levels. Lastly, the finding that repeating students achieve better in mathematics compared to first-time takers implies that students should have longer experience in learning mathematics at tertiary level. This can

be achieved by requiring them to learn basic mathematics through short-courses or splitting a mathematics course into several courses.

The present study enhances our knowledge of the causes of poor mathematics achievement at private university. However, the findings in this study cannot be generalized as the causes of low mathematics achievement at other private universities. The scope of this study was limited in terms of variables considered. Further research needs to be conducted in order to determine the true factors of low mathematics achievement. Further works may include other possible factors such cognitive and instructor factors.

6. Acknowledgements

This research work was carried at Multimedia University, Malaysia under the MiniFund Grant Scheme IP20130829007 (MMUI/130030.02.01).

References

[1] X. Ma, D. A. Klinger, "Hierarchical linear modeling of student and school effects on academic achievement," *Canadian Journal of Education*, vol. 25, no. 1, pp. 41 – 55, 2000.

[2] C. Papanastasiou, "Effects of attitudes and beliefs on mathematics achievement," *Studies in Educational Evaluation*, vol. 26, no. 1, pp. 27 – 42, 2000.

[3] S. Tobias, "Overcoming Math Anxiety," W.W. Norton, vol. 1, pp. 260, 1995.

[4] F. C. Richardson, R. M. Suinn, "The Mathematics Anxiety Rating Scale: Psychometric data," *Journal of Counselling Psychology*, vol. 19, no. 6, pp. 551-554, 1972.

[5] B. F. Sherman, D. P. Wither, "Mathematics anxiety and mathematics achievement," *Math. Educ. Res. J.*, vol. 15, no. 2, pp. 138-150, 2003.

[6] D. Elenchothy, "Kebimbangan matematik dan hubungannya dengan pencapaian pelajar tingkatan empat di daerah Klang," M.Sc Thesis, Universiti Putra Malaysia., 2007.

[7] C. A. Arem, "Conquering Math Anxiety," Cengage Learning, Belmont, ISBN-10: 0495829404, vol. 3, pp. 215, 2009.

[8] I. V. S. Mullis, M. O. Martin, P. Foy, "TIMSS 2007 international mathematics report," TIMSS & PIRLS International Study Center, 2008.

[9] I. Demir, S. Kilic, O. Depren, "Factors affecting Turkish students' achievement in mathematics," *US-China Education Review*, vol. 6, no. 6, pp. 47-53, 2009.

[10] M. Lazarus, "Mathophobia: Some personal speculations," *National Elementary Principal*, vol. 53, no. 2, pp. 16–22, 1974.

[11] K. Y. Wong, K. S. Quek, "Do Chinese and Malay students report different ways of studying mathematics?," Retrieved from https://repository.nie.edu.sg/bitstream/10497/531/1/CRP47_03WKY_Conf07.pdf, 2007.

[12] S. Morony, S. Kleitman, Y. P. Lee, L. Stankov, "Predicting Achievement: Confidence vs self-efficacy, anxiety and self-concept in Confusion and European Countries," *International Journal of Educational Research*, vol. 58, pp. 79-96, 2013.

[13] J. F. J. Hair, C. B. William, J. B. Barry, E. A. Rolph, Multivariate Data Analysis (6th edition), *Pearson Education, Inc.*, New Jersey, 2006.

[14] H. Mohamed, N. Sahari, H. Mohamad Judi, T. S. M. Tengku Wook, "Factors affecting FTSM students' achievement in statistics course," *Procedia-Social and Behavioral Sciences*, vol. 59, pp. 125-129, 2012.

[15] A. Bandura, "Self-efficacy," *Encyclopedia of human behavior*, vol 4, pp. 71-81, 1994.

[16] K. White, "The relation between socioeconomic status and academic achievement," *Psychological Bulletin*, vol. 91, no. 3, pp. 461-481, 1982.

[17] H. Abdul Rahim, R. Ab Razak, "Factors affecting Malaysian students' achievement in mathematics," Proceedings in *International Conference on Computing, Mathematics and Statistics*, Penang, 28-29 Aug 2013, pp. 57-65.